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Technical Research Note 229

RESEARCH ON TACTICAL MILITARY DECISION MAKING: III. PREDICTOR VARIABLES AND CRITERION MEASURES

Richard L. Krumm, James E. Robins, and Thomas G. Ryan
The Bunker-Ramo Corporation

SYSTEMS INTEGRATION & COMMAND/CONTROL TECHNICAL AREA

U. S. Army
Research Institute for the Behavioral and Social Sciences

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U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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NOTICES

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ARI Technical Research Reports and Technical Research Notes are intended for sponsors of R&D tasks and other research and military agencies. Any findings ready for implementation at the time of publication are presented in the latter part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

The research reported here was accomplished by the Systems Integration and Command/Control Technical Area of the U. S. Army Research Institute for the Behavioral and Social Sciences. The Institute, established 1 October 1972 as replacement for the U. S. Army Manpower Resources Research and Development Center, unifies in one enlarged organization all OCRD, activities in the behavioral and social sciences area, including those previously conducted by the former Behavior and Systems Research Laboratory (BESRL) and the Motivation and Training Laboratory (MTL).

The Command and Control Work Unit within the Army Research Institute (ARI) is concerned with human factors problems of information presentation, processing, and utilization in command and control systems. One major objective is to provide research findings by which information assimilation and decision making may be facilitated. There is a concomitant requirement for research to determine how human abilities can be utilized to enable the command information processing system to function with enhanced effectiveness.

Basic to research on command information systems are relevant and objective performance measures for use in identifying factors contributing to the overall success or failure of the system and in assessing the capabilities of system or subsystem. The present Technical Research Note describes research to develop a scenario for a test of tactical decision making and scoring standards for decision-making behavior for use in a broad program of research on tactical military decision making. Development of the scenario has been recounted in prior BESRL publications. Subsequent publications deal with tryouts and evaluation of the measure for operations planning.

ARI's Command and Control Systems research is conducted as an in-house research effort augmented by research contracts with organizations selected as having unique capabilities for research in the area. The present experiment was conducted by personnel of the BUNKER-RAMO Corporation. The entire research effort is responsive to requirements of RDT&E Project 2Q062106A723, Human Performance in Military Systems, FY 1973 Work Program, and to special requirements of the Assistand Chief of Staff for Force Development, the Assistant Chief of Staff for Intelligence, and the U. S. Army Computer Systems Command.

The present publication was prepared while BESRL existed as a separate entity. Allusions in the text to BESRL as the agency responsible for the research and monitoring the contract reflect the R&D organization as constituted prior to 1 October 1972.

J. E. UHLANER
Technical Director

RESEARCH ON TACTICAL MILITARY DECISION MAKING: III. PREDICTOR VARIABLES AND CRITERION MEASURES

BRIEF

Requirement:

To develop and evaluate a scenario for a test of tactical military decision making and to derive methods for scoring the decision-making process (as opposed to the decision itself) which, when validated, will be available for use in manned systems research to improve tactical decision making.

Procedure:

The experimentation was conducted in BESRL's Simulated Tactical Operations System (SIMTOS) facility. A test scenario was prepared and administered individually to 20 senior field grade officers. A division operations officer is required to write a defense plan for his division sector against an expected attack by two mechanized infantry divisions. Scoring standards were based on lesson plans obtained from the U. S. Army Command and General Staff College at Fort Leavenworth. The scenario was presented using cathode ray tube (CRT) displays, computer driven typewriters, and random access slide projection equipment. Defense plans were scored using the CGSC school solutions as criteria.

Findings:

The practicality of developing a priori scoring standards for complex decision-making tasks was demonstrated in the experiment. The test proved reliable. Measures of the decision-making behavior of the officers were highly correlated with the criterion score. A combination of four predictor scores, Experience, Ability, Decision Process Pattern, and Significant Facts, attained by the subject officers was highly effective in predicting the criterion score. A nonlinear relationship between total Significant Facts possessed by the officers and the criterion measures was found. Officers with very low numbers of facts to work with and those with considerable amounts scored significantly lower on the criterion measures than did officers with moderate size data bases.

Utilization of Findings:

The measure of decision quality evolved was helpful in developing a more appropriate scenario for assessing the impact of various command information system variables in a situational setting (the systems measurement bed) provided by BESRL's SIMTOS.

RESEARCH ON TACTICAL MILITARY DECISION MAKING: III. PREDICTOR VARIABLES AND CRITERION MEASURES

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RESEARCH ON TACTICAL MILITARY DECISION MAKING: III. PREDICTOR VARIABLES AND CRITERION MEASURES

INTRODUCTION

A primary objective of BESRL's COMMAND SYSTEMS research program of which the present experiment was a part is to assess the influence of various aspects of information systems upon the quality of decisions in the command and control of tactical military forces. Thus, the establishment of a criterion, i.e., a reliable measure of decision quality, is clearly a necessary first step.

The aim of the present research project is to develop such a measure, based upon a situational test of decision making oriented toward selected mission planning tasks typical of those confronting a division operations officer.

The general progression of experiments in the program is detailed in an earlier report in this series[1]. This phased approach makes possible the solution of methodological problems prior to bringing together in one final experiment the essential systems variables--decisions, displays, information requirements, and decision makers. The present experiment is the first in the series.

The phased research plan is designed to gain control over several factors that could operate to influence decision making. For example, it can be anticipated that military decision makers will vary considerably in the amount, type, and specificity of information they believe is required for the solution of a particular military problem. There is therefore a need to generate a comprehensive data base.

There existed, then, a requirement to determine the categories and level of detail of information which would realistically satisfy the planner's information needs. This systematic organization was achieved on the basis of structured interviews with senior military commanders and examination of standard military manuals defining staff responsibilities. The result was an information network which provided a checklist of information needs and flow diagrams encompassing the total information analysis and decision making sequence involved in developing portions of a division operations plan such as defensive planning[2].

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[1] Krumm, Richard L., Carlos H. Rowe, and Francis E. Torpey. (The Bunker-Ramo Corporation). Research on tactical military decision making: I. Design of a Simulated Tactical Operations System (SIMTOS). Research Problem Review 70-1. Behavior and Systems Research Laboratory. Arlington, VA. October 1970.

[2] Ryan, Thomas G. (The Bunker-Ramo Corporation). Studies of tactical military decision making: II. An information network aid to scenario development. Research Study 69-11. Behavior and Systems Research Laboratory. Arlington, VA. September 1969.

Individual preference for amounts and types of information is accentuated by subject differences with respect to prior military experience and training. In the early stages of the program, retired military officers served as consultants and as subjects in preliminary tryouts of the scenario. Experience with these officers emphasized the desirability of obtaining as test subjects officers with mechanized infantry experience and command training. (Each subject assumed the role of the G3 of a Mechanized Infantry Division). Initial guidelines were therefore established to aid in the selection of test subjects: The officers must be graduates of the United States Army Command and General Staff College (CGSC) at Fort Leavenworth, Kansas and have had experience as Commander, Assistant Division Commander, Chief of Staff, or G3 in a Mechanized Infantry Division, or have had experience as a Commander, Executive Officer, or S3 in a Mechanized Infantry Brigade.

Another consideration in establishing acceptable levels of control in the experiment was the environment within which the tests were to be conducted. The attempt was to incorporate in the test environment features of a G3 plans section of a division tactical operations center (DTOC). The testing area was to approximate the physical configuration of a staff planning section within a DTOC, including some of the tactical information displays and decision tasks that would normally be encountered there.

The DTOC was selected for the present test environment primarily because it was apparent that officers with experience at division level would be more readily available to serve as advisors and as test subjects than would officers with experience at corps or army command echelons.

Some degree of environmental realism was sacrificed in order to provide control over the test situation. For example, a division operations officer (G3) is normally aided by a substantial staff. For the individual testing in the current experiment, the G3's staff was "absent", and the officer could communicate with his "staff" or with others only by means of an input-output device communicating with a CDC 3300 computer[3]. This procedure was eminently practical in reducing the number of experimenters and test subjects required. It also provided a preliminary indication of the suitability of the information display hardware to support future, more complex experimentation in tactical operations systems.

DEVELOPMENT OF THE SCENARIO

Definition of the military tactical decision making process was a crucial aspect of scenario design, since this definition would influence the selection of information presented and determine scoring parameters. An analysis made by the Seventh U. S. Army TOS Development Group provided the departure point for the present research.

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[3] Commercial designations are used only in the interest of precise reporting. Their use does not constitute indorsement by the Army or by BESRL.

Seventh Army senior staff personnel identified eighteen problem situations as frequently appearing in tactical military operations. The 18 problem situations were analyzed in terms of 21 categories of information deemed relevant for their satisfactory solution (Figure 1). The 18 problem situations can be arranged in four major phases of what might be termed "the command cycle." Two phases are concerned with planning and two with execution. Each phase provides data for subsequent phases, and completion of the fourth phase reinitiates the cycle (Figure 2).

Problem situations listed in the first two (planning) phases of the decision cycle (Figure 2) defined the scope of the experimental task. The specific task was planning a division defensive operation.

The problem situations (Figure 1, rows) require for solution relevant information identified at least to a gross level in the Figure 1 columns (e.g., weather, terrain, enemy situation). Therefore, these are the general categories of information which the experimenter must make available in the scenario data base.

As scenario development progressed, it became evident that the Seventh Army information categories did not provide sufficient detail concerning the contents of the relevant categories, and some other means of fulfilling the information requirements of the scenario data base would be required.

This was provided by the "information network" referred to previously which was based upon detailed expositions of military staff responsibilities presented in Army field manuals. The decision sequence for developing an operations plan provided the basic structure of the network, which then specified information categories and likely sources of such information. These data were combined with information available in CGSC lesson plans for a division defensive operation in order to create the present decision-making scenario.

TEST AREA

The scenario was administered at the BESRL research facility. The test cubicle conformed to an arrangement the subjects might expect to encounter in a G3 plans section of a fully automated DTOC and included situation maps and data tables. The computer communication devices were arranged conveniently so that the officer could readily review his tactical information.

The test area was a 12' x 8' cubicle which served as the simulated G3 plans area, and a 4' x 6' cubicle for the experimenter. In the test area were a work table, an input/output console, an electrical typewriter output from the computer, a 1:250,000 scale military planning map, a 1:50,000 scale situation map, a rear projection display screen, a random access 35mm slide projector driven by the computer, and a telephone connected with the experimenter station (Figure 3). The experimenter station included a work table, an input/output console, and a telephone (Figure 4).

	ENEMY SITUATION & STATUS	TERRAIN	WEATHER	EFFECTIVE WIND MESSAGE	TRAFFIC OBSTACLES & BOTTLENECKS	ACFT AVAIL-ABILITY	AIRFIELD LOCATION	TRUCK TRANSP. AVAIL-ABILITY	BRIDGING	TAC. TROOP MOVEMENT	AREA DAMAGE CONTROL	FRIENDLY SITUATION & STATUS	TASK ORG.	TAC. AIR FIRE SUPPORT	TACTICAL AIR RECON.	STATUS OF NUCLEAR FIRE MISSION	READINESS OF NUCLEAR DELIVERY SYS.	NUCLEAR ALLOC. AND POSITIONING	BARRIERS	CRITICAL SUPPLY ITEMS	TARGETING	ISSUE AN ORDER
1. MOVE A MANEUVER UNIT																						
DECISION REQUIRED	[X]			[X]								[X]										
DEVELOPMENT RECOMMEND	X	X	X	X		X	X	X				X	X		X	X			X	X	X	
IMPLEMENT DECISION					X	X	X	X	X	X		X	X	X					X	X		✓
IMPACT DECISION					—	—		—	—	—		—	—	—					—	—	—	
2. MOVE A FIRE SPT UNIT																						
DECISION REQ.	[X]	[X]										[X]										
DEVELOP	X											X		X		X	X	X				
IMPLEMENT	X			X	X				X	X		X		X			X	X	X			✓
IMPACT					—			—	—	—		—	—	—			—	—		—	—	
3. MOVE A COMBAT SRC SPT UNIT																						
DECISION REQ.	[X]			[X]							[X]	[X]						[X]		[X]		
DEVELOP	X	X	X	X	X	X		X			X	X	X					X		X	X	
IMPLEMENT					X	X	X	X	X	X		X	X					X		X		✓
IMPACT					—	—		—	—	—		—	—					—		—	—	
4. CHANGE A BOUNDARY																						
DECISION REQ.	[X]											[X]	[X]									
DEVELOP	X	X			X							X	X								X	
IMPLEMENT												X	X									✓
IMPACT												—	—	—					—		—	
5. ASSIGN NEW OBJECTIVES																						
DECISION REQ.	[X]	[X]										[X]			[X]							
DEVELOP	X	X	X						X			X		X	X					X	X	
IMPLEMENT																						✓
IMPACT												—	—	—		—		—	—	—	—	
6. CHANGE MISSION MANEUVER UNIT																						
DECISION REQ.	[X]	[X]										[X]			[X]				[X]			
DEVELOP	X	X	X		X							X	X	X	X				X	X	X	
IMPLEMENT												X	X									✓
IMPACT												—		—	—				—	—	—	
7. CHANGE MISSION FIRE SPT UNIT																						
DECISION REQ.	[X]											[X]		[X]							[X]	
DEVELOP	X											X		X		X	X	X			X	
IMPLEMENT													X									✓
IMPACT												—	—				—	—				
8. CHANGE MISSION COMBAT SVC SPT UNIT																						
DECISION REQ.	[X]										[X]	[X]								[X]		
DEVELOP	X							X			X	X	X							X		
IMPLEMENT								X														✓
IMPACT								—		—		—	—							—		
9. REALLOCATE CRITICAL SUPPLY ITEM																						
DECISION REQ.	X											[X]								[X]		
DEVELOP	X	X	X			X				X		X								X		
IMPLEMENT					X	X		X		X										X		✓
IMPACT						—		—		—		—								—		
10. ORDER BARRIER PLAN EXECUTION																						
DECISION REQ.	[X]											[X]			[X]							
DEVELOP	X	X	X	X						X		X							X			
IMPLEMENT																		X	X			✓
IMPACT					—				—	—		—						—	—			
11. COMMIT A RESERVE UNIT																						
DECISION REQ.	[X]											[X]							[X]			
DEVELOP	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	
IMPLEMENT										X		X	X	X								✓
IMPACT						—	—	—	—	—		—	—	—	—	—		—	—	—	—	
12. RECONSTITUTE A RESERVE																						
DECISION REQ.	[X]											[X]			[X]							
DEVELOP	X	X			X					X	X	X	X	X	X	X		X	X	X		
IMPLEMENT						X	X	X		X		X	X	X	X	X		X	X	X		✓
IMPACT					—	—		—		—	—	—	—	—	—	—		—	—	—		
13. GIVE PRIORITY OF FIRE																						
DECISION REQ.	[X]											[X]		[X]	[X]							
DEVELOP	X	X										X	X	X	X	X	X	X		X	X	
IMPLEMENT												X	X	X		X	X	X		X		
IMPACT												—	—	—	—			—			—	
14. GIVE PRIORITY OF LOGISTIC SUPPORT																						
DECISION REQ.	[X]											[X]								[X]		
DEVELOP	X					X		X				X	X							X		
IMPLEMENT													X							X		✓
IMPACT						—		—					—							—		
15. CHANGE IN EEI																						
DECISION REQ.	[X]	[X]										[X]			[X]							
DEVELOP																						
IMPLEMENT		X	X			X						X	X		X							
IMPACT						—						—	—		—							
16. RELEASE OF NUCLEAR WEAPONS																						
DECISION REQ.	[X]											[X]			[X]						[X]	
DEVELOP	X		X	X								X					X				X	
IMPLEMENT													X				X	X	X			✓
IMPACT												—	—		—	—	—	—	—		—	
17. ALLOC & POS OF NUCLEAR WPNS																						
DECISION REQ.	[X]											[X]	[X]			[X]		[X]			[X]	
DEVELOP	X	X										X	X	X		X		X	X	X	X	
IMPLEMENT						X	X					X		X		X		X				✓
IMPACT						—						—										
18. LAUNCH A SPECIAL OPN (RVR XING)																						
DECISION REQ.	[X]											[X]			[X]							
DEVELOP	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
IMPLEMENT					X	X	X	X	X	X			X	X	X	X		X	X	X	X	✓
IMPACT					—	—		—	—	—		—	—	—	—	—		—	—	—	—	

Figure 1. Eighteen 7th Army key decisions

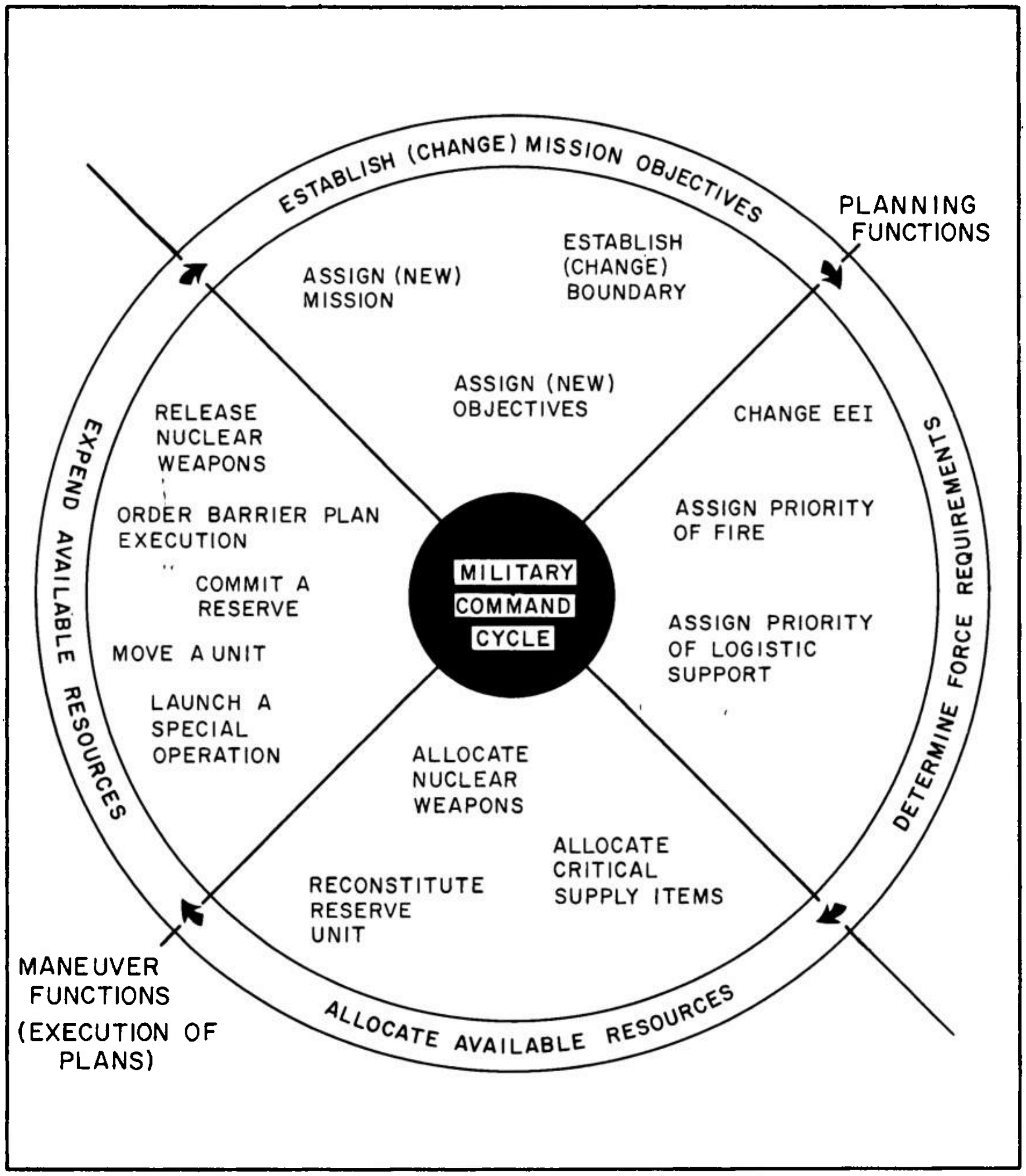

Figure 2. Examples of typical decision situations in the military command cycle

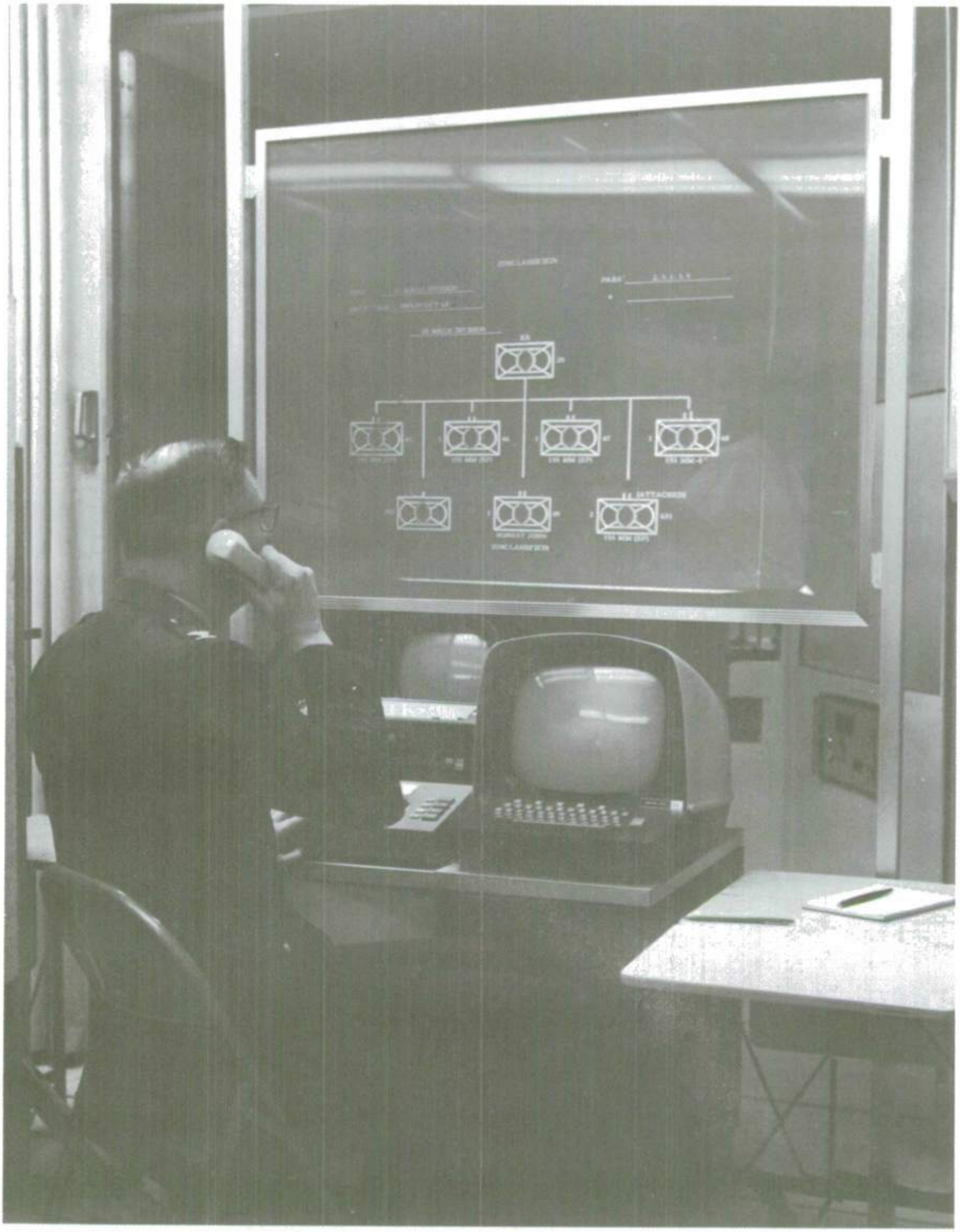

Figure 3. Subject work area

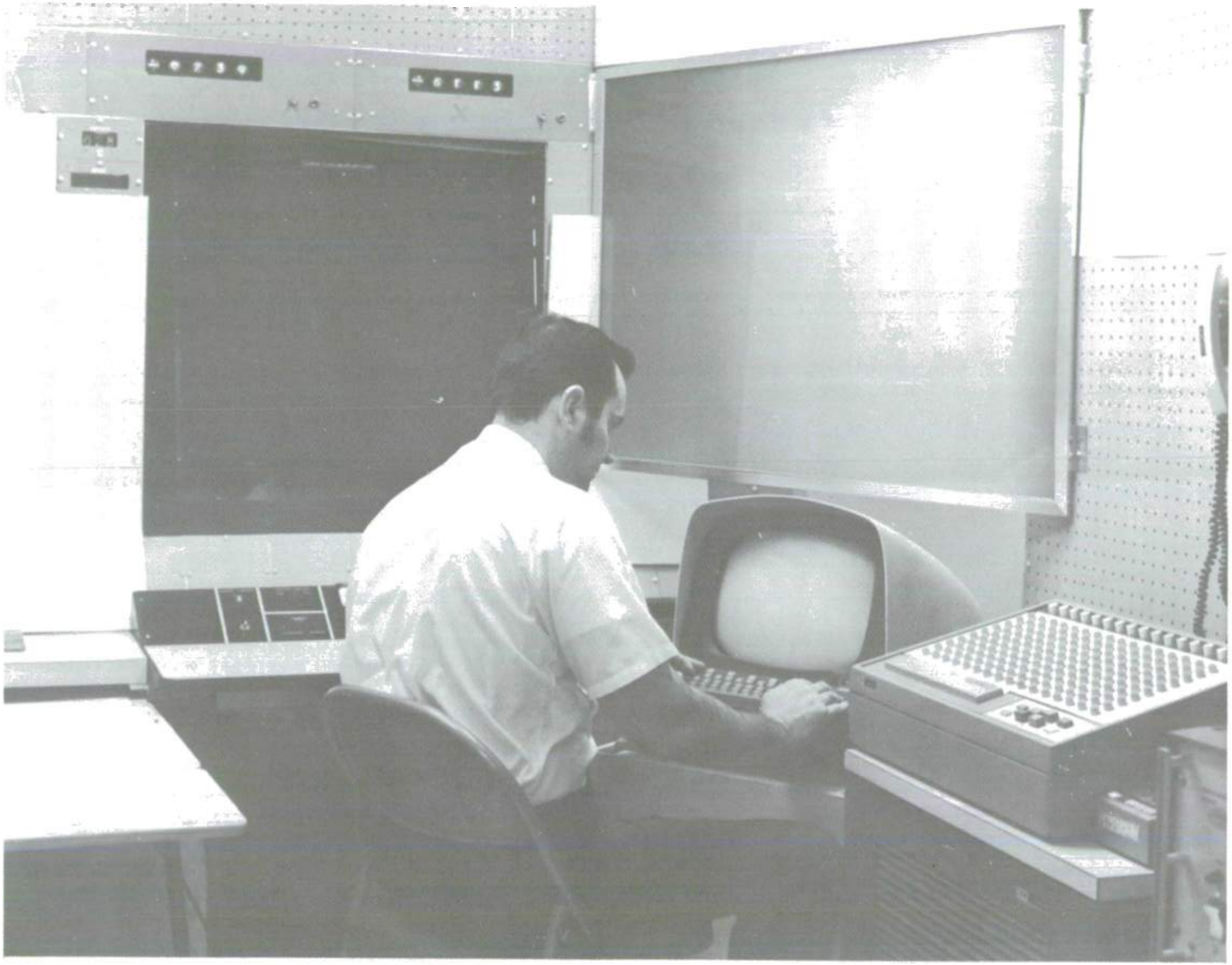

Figure 4. Experimenter work area

EXPERIMENTAL SUBJECTS

A total of 20 lieutenant colonels and colonels participated in the experiment, not counting additional colonels and generals who served as pilot study subjects and as technical advisors. All the officers were in active duty status in the greater Washington area. Their ages ranged from 35 to 49 years and their military service time from 13 to 28 years. All but one were college graduates and eight had had some graduate school training. All subjects had had combat experience, three in World War II, ten in Korea, and eighteen in Vietnam. Total combat experience ranged from 9 to 37 months. With respect to military experience in Germany (problem setting), advanced troop test experience was reported by seven, command post exercises by seven, and field training exercise by fifteen.

TEST PROCEDURE

The subject was introduced to the test area and briefed on the operation of the equipment and the tasks he was expected to perform. This briefing was standard for each test subject and appears as Appendix A.

The subject was then given a printed copy of portions of a Corps Operations Order assigning him his mission (Appendix B). He was advised that in order to fulfill the assigned mission he might require information stored in the computer. Access to this information was to be gained through the experimenter with whom the subject communicated by means of a telephone. The general procedure was for the subject to request information which the experimenter would retrieve for display on the cathode ray tube (CRT) of his input/output console, review to be sure it was the requested information, and then transmit to the subject's station.

The requested information was displayed primarily on the subject's CRT, although some data were displayed on a rear projection screen. In either case, "hard copies" were provided if requested by the subject. Copies of data displayed on the CRT were provided by the experimenter, who would instruct the computer to print the message on the subject's typewriter; copies of projected displays were delivered by a "messenger." In lieu of requesting copies of the displayed data, the subject was permitted to transcribe any of the displayed information manually if he so desired.

The experimental tasks were organized according to the decision sequence recommended in Army field manuals[4] for developing an operations plan. This sequence provided a logical means of dividing the total test into three segments or subtests. To prevent subjects' being penalized late in the decision sequence for "errors" they may have made early in the test, they were provided with "commander's guidance" at the end of

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[4] See, for example, FM 101-5, Staff Officers Field Manual Staff Organization and Procedure, Headquarters, Department of the Army, June 1968.

Subtests I and II. If a subject recommended mobile defense during Subtest I, he was informed that the commander had decided upon an area defense and that the next portion of his planning was to be based on that guidance. This sort of difference of opinion is not unusual in the military environment. It did not seem to trouble the subjects to be told that the commander did not accept a certain recommendation. Moreover, the procedure provided a means of controlling departures from the intended scenario, and insured that all subjects were scored on corresponding portions of their decision-making behavior.

During Subtest I, the subject was requested to identify enemy avenues of approach into his division sector, to identify key terrain features, and to recommend a form of defense. It was recognized that identification of avenues of approach and key terrain is normally a G2 responsibility, but military experts indicated that these items could be answered by subjects with G3 or commander experience.

When the subject had completed Subtest I, he received "commander's guidance" which indicated that the "commander" had elected to use an area defense and, as Subtest II, wanted the subject to develop a course of action based on that concept. The subject was requested to allocate maneuver elements to the echelons of defense (including a task force on the general outpost line, his forward defense area forces, and his reserve forces) and to recommend the type of resistance to be offered by each echelon of defense. The subject recorded his decisions on data sheets provided.

At the completion of Subtest II, the subject again received "commander's guidance" regarding the course of action, and, as Subtest III, was requested to develop the graphic portion of the defense order, sketching it on his situation map overlay and indicating his recommended location of the general outpost, combat outpost coordination point, brigade boundaries, forward defense area, battalion positions, reserve force location, visualized allowable enemy penetrations, and blocking positions.

In addition, the subject was requested to write his recommended task organization and to write mission statements to subordinate units. The mission statements completed Subtest III.

An experimenter log was maintained which listed the requests for data made by each subject, including the essential content of the request, time of the request, location of the data, and time at which the response was sent. This record included a notation of whether the data were displayed on the CRT or on the projection screen and whether hard copies had been requested.

After the test, each subject was requested to complete a questionnaire concerning his military experience and his civilian and military education. The questionnaire also solicited the subject's impressions concerning the scenario and his willingness to assist in its further development.

SCORING PROCEDURES

Criterion Measures

The CGSC lesson plans were used as one basis for scoring subject's responses, since the plans had been meticulously developed over several years by military instructors with combat experience. One complication arose, however, when local project military advisors suggested that for purposes of realism a mechanized infantry division be used in the scenario rather than the "straight-leg" infantry division on which the CGSC lesson plans were based, since only mechanized infantry units are currently used in the Seventh Army in Europe. This recommendation was referred to the CGSC. The CGSC indicated to the project staff that this proposed change in force structure was not likely to affect the basic character of the subjects' answers since the rugged terrain in the scenario area nullified the advantage of increased mobility which mechanized units would otherwise possess. Therefore, the change was made.

Another change in the CGSC lesson plan involved change from a combat situation to a pre-combat planning situation. This change was considered desirable since aspects of the scenario will be used in future experiments involving decision making in simulated combat settings. The pre-combat setting enables a subject to gain full familiarity with the strengths and location of forces under his command prior to his having to make decisions concerning the judicious employment of forces in a simulated battle. In an actual combat situation, a decision maker will generally be thoroughly aware of preceding events, his unit's relationships to its parent organization and to adjacent units, characteristics of enemy commanders, enemy order of battle, etc. This fundamental knowledge is essential in selecting an appropriate course of action.

Instructors at the CGSC felt that the correctness of school solutions presented in the lesson plans would not be affected by these modifications made to the force structure and tactical setting. Therefore, rationales and solutions in the CGSC lesson plans were used as one basis for developing objective scoring measures of decision quality. The quantitative values assigned to each response during the entire scenario are defined in Appendix C for this particular scoring procedure identified as "Leavenworth Standard."

A second scoring technique was also examined, identified herein as "Consensus Standard." This technique was developed for use in the event the CGSC standards were inappropriate as a result of the changes made in the scenario. The technique provides for computing average subject responses at certain decision points. Subjects whose answers approximated the group answer received maximum scores.

Predictor Variables

While it was hypothesized that the total score a subject received on a test of decision making would be a function of four major variables, it was not clear what measures could be used to represent fully the desirable content of the four variables. Consequently, the data analyses included a large number of exploratory efforts (e.g., various item weights, various data transformations, predictors of various types). The four major variables hypothesized were: the subject's experience, his ability, the amount of information he possessed relevant to the problem, and the pattern of behavior he exhibited in arriving at a solution. It is this last variable, the decision process pattern, that is of fundamental importance to the proposed series of decision making experiments, since it is the only one of the four variables reasonably independent of the specifics of a problem situation. Consequently, if it can be determined that a given decision behavior pattern is related to decision quality, then a measure of that pattern might serve as an adequate substitute for a measure of decision quality in future problem situations for which no criterion is available.

Three of the above four major variables were composite scores, obtained by averaging standard score conversions of component measures. The four major variables and their component measures and procedures employed for their computation are described below.

The Experience Composite (ELIX)[5]. A subject's experience score was an arithmetic mean of three component scores, each of which was converted to a standard score based on the unit normal curve: 1) a score related to the date the subject attended the U. S. Army Command and General Staff College at Fort Leavenworth (EL), 2) the amount of experience the subject had had in mechanized infantry units (EI), and 3) the number of field exercises he had participated in (EX).

The (EL) score was derived by allocating points for recency of attendance in the regular training course at CGSC. Twenty-five points were allotted if the questionnaire completed by the subject indicated that he had attended CGSC during the two-year period prior to the test, twenty points if he had attended CGSC three or four years prior to the test, fifteen points if CGSC attendance was five or six years ago, etc. Zero points were allotted if he had attended CGSC more than ten years ago or if he had never attended CGSC. No credit was given for attendance at military schools other than CGSC. The allotted score was then modified by deducting five points if the subject had been enrolled in a CGSC course other than the complete regular course of instruction.

[5] Details concerning these scoring procedures appear in Appendix D. The letters in parenthesis are variable labels.

The score for experience in a mechanized infantry unit (EI) was derived by considering the command echelon, the level of job responsibility, and duration of the assignment in months (Appendix D). These data were obtained from the questionnaire completed by the subjects. The scoring rationale was based on the assumption that experience in a mechanized division would be more valuable for present problem purposes than experience in a mechanized brigade. Similarly, experience as a brigade S3 would be more valuable (again, for present problem purposes) than experience as a brigade S2 or S4. Finally, twelve months'experience would presumably be more valuable than eleven months or ten months. No credit was given for experience in any military unit other than a mechanized infantry unit, even though a mechanized infantry unit may have been included as an echelon subordinate to the one in which the test subject had served.

The exercise experience score (EX) was derived simply by counting the number of field exercises the subject reported he had participated in while assigned to duty in West Germany. The exercises of interest included command post exercises, field training exercises, map exercises, and advanced troop tests. No credit was given for exercises other than those held in West Germany. The rationale for this score was that such experience might be advantageous since the present test scenario was based on the West German locale and terrain would be familiar, as well as types of units and their tactics. The tasks expected of the subject were similar to those normally included in training exercises conducted in Germany.

<u>The Ability Composite (ALCW)</u>. Two scores comprised this variable. The first (ALC) represented the subject's class standing at graduation from CGSC, expressed as a percentage score based on the number of students in his class. The second score (ALW) was an overall final rating assigned by CGSC on the subject's ability to express himself. General Classification Test scores might have been more appropriate measures of subjects' general ability, but such scores were not available to the investigators. The above scores were considered reasonable substitutes under the circumstances. Mean scores were inserted as estimates of ability scores for subjects who had not attended CGSC. Desirable class standing scores were, of course, the smaller percentage values; the class standing percentages were therefore subtracted from a constant (1.000) prior to conducting further analyses. The two sets of scores were normalized and averaged to derive the composite score of ability.

<u>Decision Process Pattern (DPP)</u>. This score was a composite of four normalized pattern scores: request dyad sequence (PSEQ), data request runs (PDRR), request slope (PRS), and terminal pause (PTP).

The following procedure was used to identify and to score the request dyad sequence pattern (PSEQ). The subject's requests for information which had been transcribed by the observer during the test were assigned a code number in terms of the following eleven categories:

1. Friendly Unit Task Organization
   Attachment, support, and operational control

2. Friendly Unit Tactical Dispositions
   Front line trace
   Command post locations
   Center of mass
   Unit boundaries
   Reserve locations
   Objective locations
   Supporting troop locations

3. Friendly Unit Operational Activities
   Current activities
   Planned activities
   Summary of activities

4. Friendly Unit Status Information
   Strength
   Casualties
   Morale
   Combat effectiveness
   Critical supply items

5. Weather
   Visibility
   Precipitation

6. Terrain
   Cover and concealment
   Fields of fire
   Road nets and status
   Soil trafficability
   River fordability
   Presence of bridges and their status

7. Enemy Unit Task Organization
   Attachment, support, and operational control

8. Enemy Unit Tactical Disposition
   Front line trace
   Command post locations
   Center of mass
   Unit boundaries
   Reserve locations
   Objective locations
   Supporting troop locations

9. Enemy Unit Operational Activities
   Current activities
   Planned activities
   Summary of activities

10. Enemy Unit Status Information
   Strength
   Casualties
   Morale
   Combat effectiveness
   Critical supply items

11. Miscellaneous
   (primarily civil affairs)

Each subject's requests were organized along a time base (in five-minute time blocks) so that a string of numerical codes represented the sequence and nature of each subject's requests for information. Each successive set of two numbers was then studied. A tabulation was made of the frequency with which each category followed another. In other words, each set of two successive numbers (dyads) was studied to determine whether a request in one category was more likely to be followed by one category than by another. Such a relationship was, in fact, discovered. An 11 x 11 matrix of successive category tabulations (with the first number of a dyad entered on the rows and the second term indicated in the appropriate column) yielded a contingency coefficient of .68, and a Chi square value beyond the .01 level of probability. Examination of the cell contingencies in the matrix indicated that the entries in the diagonal were largely responsible for the relationship. Many subjects, for example,

having accessed the terrain category, would ask additional questions in that category before turning to a different topic. Thus, the sequence score for each test subject (PSEQ) was the number of his dyads whose category numbers were identical, divided by his total number of dyads.

The score for data request runs (PDRR) was developed using the definition that is used for the non-parametric statistic called the Wald-Wolfowitz Runs Test[6]. The numerical codes indicating each subject's request categories had been entered in appropriate five-minute time blocks. One or more requests in a time block signified that the time block was filled. One or more consecutive filled blocks was defined as a run. Similarly, one or more consecutive unfilled blocks was also a run. A subject's score was the total number of such runs prior to the time block in which he stated his final decision. Desirable scores were the lower scores; therefore, to obtain a positive correlation, the number of runs was subtracted from an arbitrary constant (30) prior to normalizing.

For each subject, the cumulative percentage of requests as a function of time was computed. A monotonic relationship was found between this variable and total decision quality test score based on the Leavenworth Standard. Subjects in the top quartile had made 80 percent of their requests in the first 75 minutes of the problem. Mean times for successive quartiles to reach the 80 percent point were 115, 125, and 142 minutes, respectively, for quartiles two, three, and four. Similarly, the 90 percent point was reached by the four quartile groups after 120, 150, 165, and 200 minutes, respectively. The cumulative percentages of requests at 30, 60, and 90 minutes were selected for further study because it was found that some subjects completed their work prior to the 120-minute point and their cumulative request percent scores were therefore at a maximum value during the 90-120 minute stages. The cumulative percentage increments were computed for the 0-30, 30-60, and 60-90 minute periods, and each value was divided by 30 to yield a "percent per minute" score for its respective 30-minute time period. The mean 0-30 increment value was compared with the mean 30-60 increment value, and the mean 30-60 increment value was then compared with the mean 60-90 value. In these two comparisons, if the first value exceeded the second value by a specified amount (in this case, more than 0.2 percent), three points were credited. If the values were essentially even (±0.2 percent), two points were credited. If the second value exceeded the first by more than 0.2 percent, one point was allotted. Thus, for the two comparisons (0-30 vs 30-60 and 30-60 vs 60-90) a subject's request slope score (PRS) could range from two to six points. This is a restricted range, and is undesirable for correlational purposes. It could possibly be extended in the future as test duration increases. Also, additional data points (and greater score dispersion) could have been provided by scoring cumulative requests for successive 15-minute periods rather than 30-minute periods. However, time periods shorter than 30 minutes were found to be too brief to establish stable scores for this variable.

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[6] Siegel, S. Non-parametric statistics for the behavioral sciences. New York: McGraw-Hill, 1956, p. 136.

The terminal pause score (PTP) is the number of minutes which elapsed from the time of the subject's final request for data and the time he submitted his decision. This measure ranged from less than one minute to 150 minutes, with a mean value of 40 minutes. Desirable scores appeared to be the brief times; therefore, the scores were subtracted from a constant. This score, as was the case with each of the foregoing, was normalized prior to conducting subsequent analyses.

Facts Possessed (FACT). None of the above three major variables or their component measures takes into account the content of the information presented to the subject. This scoring strategem was intentional because of the desirability of deriving a predictive measure which would be independent of the specific information content relevant to a decision situation. (The DPP score might be considered to be related to facts possessed since, theoretically at least, the nature of the information provided in response to a question could influence a subject in expressing his next question. However, subsequent correlational analyses failed to reveal a statistically significant relationship between the DPP and FACT variables).

The three composite measures of experience, ability, and decision process pattern were entered in a multiple regression equation to predict each subject's total decision quality score. Comparison of the obtained and the predicted scores permitted identification of over-achievers (defined for this particular score distribution as those whose obtained score exceeded their predicted score by at least 0.3 standard deviation) and under-achievers (those whose obtained score was less than the predicted score by at least 0.3 standard deviation). These over-achievers and under-achievers provided the basis for identifying significant facts, and eventually for computing the facts-possessed score. It was hypothesized that the over-achievers may have possessed information which was not possessed by the under-achievers and that this information gap would at least in part account for the disparity between obtained and predicted scores. (The over-achievers and under-achievers were not necessarily among the top and bottom scorers, respectively; and comparisons of the top and bottom scorers had failed to reveal reliable differences with respect to number or type of facts possessed).

One further point should be noted. In the present context, the term significant facts refers to facts which were significant in distinguishing between groups of identified over- and under-achievers. It is not assumed that these facts are the only ones relevant to present problem solutions, since many of the available facts were possessed in common by many of the test subjects.

Each CRT display was scored in terms of the number of facts it contained. A fact was defined for present test purposes as a phrase or a simple sentence or as the basic information which would be used to form a simple sentence. For example, the following would qualify as facts:

a. "replacements will not be available for 10-15 days" (category 4, relevant to friendly unit strength).

b. "light shower activity is possible on 8 and 9 October/with ground fog to 1000 hours" (two facts, each relating to weather conditions, category 5).

c. "the area is drained by the Saale, Regnitz, and Weisse-Elster Rivers" (relevant to category 6, terrain data).

d. "the third brigade consists of the 1-70 and 1-71 Mechanized Battalions" (category 1, relating to friendly unit task organization).

e. "the 23d Armored Division is corps reserve/located in the vicinity of Kronach" (two facts, one relating to category 1, task organization, and one to category 2, friendly unit disposition).

f. 20th DIVARTY (PA7554) (relating to category 2, friendly unit dispositions).

The number of facts for each CRT display was obtained. Facts were classified in terms of the same categories as requests for information. The CRT display frames that appeared to distinguish between over-achievers and under-achievers were extracted for further analysis. These were arbitrarily defined as frames which had been requested 1.5 times more frequently by persons in the over-achiever category than by the under-achievers. The facts in these CRT frames were considered significant, and a score was computed for each test subject which was the sum of such significant facts which had been requested by him divided by the total number of facts requested by him during the test.

It was found that this fact percent score was related to test subject sequence. There had been a gradual but statistically significant increase in the mean number of facts displayed to successive subjects during conduct of the tests, despite experimental controls involving use of only one experimenter and use of a standard set of instructions. The net effect of such changes was, of course, to increase the probability that subjects tested late in the sequence would obtain <u>significant facts</u> which had not been displayed to subjects tested early in the sequence. Therefore, a correction was introduced in the <u>facts possessed</u> score by dividing the percentage score for facts possessed by the number of requests made by each subject. This step reduced the correlation between the FACT score and the decision quality score criterion, but the present <u>facts-possessed</u> score is more trustworthy because the undesirable order effect has essentially been neutralized.

A standard score conversion table for the above predictor variables appears as Appendix E. The standard scores are based on a mean of 50 and a standard deviation of 10.

RESULTS

The research had a dual purpose: to develop a reliable criterion measure of the quality of tactical military decisions, and to determine the feasibility of developing predictors of decision performance in situations where criterion measures of performance are not available. Each of these goals was met.

The Criterion Measure of Decision Quality

To aid in selecting the best combination of predictors and to determine the relative merits of a priori scoring (using the Leavenworth Standard) and a posteriori scoring (using the Consensus Standard), correlation coefficients were computed between experience and ability variables and Leavenworth and Consensus test scores. Results are presented in Table 1.

None of the coefficients between experience and ability variables and Consensus Standard scores approached statistical significance (.40) for this sample size. Also, averaging the individual reference variable scores for either <u>experience</u> or <u>ability</u> and relating the composite scores to the decision quality score resulted in higher correlation. As a consequence of these analyses, all subsequent work was performed using composite scores as predictors and the Leavenworth Standard as the criterion.

Table 1

PRODUCT MOMENT CORRELATION BETWEEN REFERENCE VARIABLES AND THE TWO SCORING STANDARDS

	Leavenworth Standard	Consensus Standard
Experience: CGSC	.20	.07
Experience: Infantry	.43	.08
Experience: Exercises	.46	-.04
Experience: Composite	.49	.05
Ability: Class Standing	.47	.19
Ability: Expressiveness	.42	.13
Ability: Composite	.53	.19

In the full test there were 55 scorable items, some of which involved multiple responses (e.g., indicating all blocking positions was a single test item but could involve as many as 17 identified locations). The total possible score was 74.0. Raw scores ranged from 25.5 to 54.0 with a mean of 39.3 points. The test was item-analyzed to eliminate test items outside difficulty limits of 25-75 percent and to eliminate items with zero or negative discriminating power between upper half and lower half of the total score distribution. These modifications resulted in a reduction in the number of scorable items to 34, yielding a total possible score of 56.

Reliability estimates were computed for both the original form and the item-analyzed form of the test. Horst's generalized formula for internal consistency reliability estimates yielded a value of .99 for the original form of the test[7]. Application of the Kuder-Richardson formula KR-21 gave values of .91 for the original form of the test and .94 for the revised form[8]. These reliability estimates are encouragingly high for this type of test, particularly since the KR-21 formula provides a conservative estimate of test reliability when item difficulties are unequal.

The test scores were negatively related to amount of time required by the subjects to complete individual subtests or to complete the total test (Table 2). This result provided a guideline for developing the Decision Process Pattern predictor score.

Table 2

PRODUCT MOMENT CORRELATION BETWEEN DECISION QUALITY SCORES AND TIME REQUIRED TO COMPLETE TESTS

Subtest 1	Time vs Score:	-.62
Subtest 2	Time vs Score:	-.43
Subtest 3	Time vs Score:	-.11
Total Test	Time vs Score:	-.59

Table 3 presents the product-moment correlation coefficients of each of the decision process pattern scores and the criterion measure (Leavenworth Standard). The intercorrelations are low among the four individual measures. Each is related to the criterion measure and their composite (mean of four standard scores) correlates .70 with the criterion.

Table 3

INTERCORRELATION MATRIX OF DECISION PROCESS PATTERN SCORES AND LEAVENWORTH STANDARD

	Sequence	Runs	Slope	Lapse	Leavenworth Standard
Sequence	--				.53
Runs	.10	--			.49
Slope	.05	.17	--		.44
Lapse	.20	-.11	-.13	--	.23

[7] Horst, A. P. A generalized expression for the reliability of measures. Psychometrika, 1949, 14, 21-32.

[8] Kuder, G., and M. Richardson. The theory of estimation of test reliability. Psychometrika, 1937, 2, 151-160.

The <u>Facts</u> Analysis

The three composite predictor scores of experience, ability, and decision process pattern were combined in a multiple regression equation, as described in the previous section of this report. Table 4 presents data from this step. The resulting equation, R = .5410 DPP + .3741 ELIX +.2374 ALCW - 7.625, was used to predict the subject's decision quality scores. A multiple correlation coefficient of .83 was obtained. The predicted scores were compared with obtained scores, and subjects whose obtained scores differed from predicted scores by 0.3 standard deviation were labeled over-achievers or under-achievers.

Table 4

MULTIPLE REGRESSION TABLE FOR THREE COMPOSITE PREDICTORS

Variable	Coefficient	Std. Error of Coeff.	Beta
Decision Process Pattern	.7165	.2065	.5410
Ability	.2180	.1423	.2374
Experience	.3999	.1512	.3741

The facts score was computed as described previously and was found to correlate .56 with the decision quality criterion score. Consequently, the facts score was combined with the three composite predictors in a second regression equation (Table 5). Addition of the facts score raised the multiple correlation coefficient to .91 using the regression formula: R = .5490 DPP + .1920 ALCW + .2373 ELIX + .4059 FACT - 19.21. The standard error of R was .09, and the F ratio of 3.24 for $n_1 = 1$, $n_2 = 18$ gave a probability less than .001 that the true correlation is zero.

Table 5

MULTIPLE REGRESSION TABLE FOR FOUR PREDICTORS

Variable	Coefficient	Standard Error of Coefficient	Beta
Decision Process Pattern	.7271	.1560	.5490
Ability	.1763	.1085	.1920
Experience	.2537	.1217	.2373
Fact	.3149	.0879	.4059

Table 6 presents the intercorrelations among the four predictor scores and indicates the correlation of each with the criterion measure of decision quality.

Table 6

INTERCORRELATION MATRIX OF PREDICTORS AND CRITERION

Variable	DPP	ALCW	FACT	ELIX	Criterion
Decision Process Pattern	--				.70
Ability	.43	--			.53
Fact	.08	.15	--		.56
Experience	.16	.14	.35	--	.49

The relatively low intercorrelations in Table 6 illustrate the independence of the four predictor scores. The substantial (.70) correlation between the decision process pattern score and the criterion is also worthy of note.

Table 7 presents product-moment intercorrelations among the individual predictor scores and indicates their respective relationships with the criterion measure. Once again, the low intercorrelations of the predictors are noteworthy.

Table 7

INTERCORRELATION MATRIX OF INDIVIDUAL PREDICTOR SCORES AND DECISION QUALITY CRITERION SCORE

	EL	EI	EX	ALC	ALW	SEQ	RUNS	SLOPE	LAPSE	FACT	CRITERION
EL	--										.10
EI	.06	--									.43
EX	.20	.62	--								.43
ALC	-.03	.07	.08	--							.54
ALW	-.01	.04	.34	.43	--						.36
SEQ	-.38	.04	.08	.61	.29	--					.53
RUNS	.15	.28	.04	.29	.02	.10	--				.49
SLOPE	.15	.23	.20	-.03	.05	.05	.17	--			.44
LAPSE	.07	.43	.47	.17	-.09	.20	-.11	-.13	--		.23
FACT	-.09	.15	.03	.10	.04	.11	.42	.65	-.39	--	.50

Additional Analyses

The decision situations were presented with the assumption that they could not be solved satisfactorily without accessing information in the data base. The exact items of information which are relevant to the particular decision situations can be hypothesized but are not definitely known. They may, however, be inferred from study of data request patterns of "successful" subjects.

Presumably, the subjects with the highest test scores possessed the necessary and sufficient information to obtain these test scores (assuming scoring standards were appropriate). Therefore, the research task included comparing data request patterns for high and low scorers to determine what data were accessed by the high, but not by the low, scorers. These data presumably would then explain the difference in scores. This analysis was conducted, with negative results. No difference could be discovered between high and low scorers with respect to the types or amounts of data they had accessed during the problem. The product-moment correlation coefficient between "number of facts possessed" and the criterion measure of decision quality was -.07. Consequently, the investigation was changed to the fact scoring described above, based on overachievers and under-achievers. However, the absence of a relationship between number of facts possessed and the criterion measure appeared to be inconsistent with what might logically be expected in this type of test. Therefore, a scattergram was plotted. The scattergram suggested that a quadratic relationship might exist between number of facts possessed and the criterion score. A test for curvilinearity verified this; Eta was equal to .62. This yielded an F ratio of 3.24 which, for degrees of freedom of 13 and 8, was significant at the .05 level of confidence. Observation of the scattergram suggested that the bow of the curve was in the region of 80-90 facts. High scorers on the criterion measure appeared most frequently in this range. Low scorers were working with fewer, or with substantially more, facts.

DISCUSSION

The findings are encouraging, particularly with respect to the significant contribution of the decision process pattern score. The high internal consistency estimate of the criterion score indicates that reliable a priori scoring standards can be established to evaluate decisions. And the substantial multiple correlation of the four composite predictor measures with the criterion (.91) suggests the desirability of further testing of the scoring concepts developed.

A primary intention was to determine whether a reliable scoring technique could be developed for a test of tactical military decision making. Such a reliable measure could then serve as the dependent variable for subsequent experiments in which independent variables might be based on display formats, amount and type of information, or information input rates. The feasibility of developing a reliable scoring method was examined using a relatively small sample of test subjects. Such a small sample cannot, however, be recommended for the development of stable

prediction equations, an effort which was undertaken in the present research as an auxiliary issue. Consequently, it is recognized that the correlational values obtained will change somewhat when the derived scoring techniques are applied to a second subject sample.

Also, the multiple prediction equation will shrink upon cross-validation. Chance relationships contributing to the magnitude of the correlation were unavoidably capitalized upon in deriving the initial multiple coefficient. In the present case, an estimated correction for shrinkage reduced the multiple correlation coefficient to .86.[9] In addition to this characteristic shrinkage, there will be other factors operating to reduce the discovered relationship. These include not only differences in test subject characteristics and test content, but also major differences in test administration procedures. The changes in test administration procedures (which will be necessitated by the tactic of having each subject address the data base directly) may exert a particular and substantial effect upon the request sequence score and the runs score.

Finally, there are considerations more subtle than the foregoing which may also have an effect upon the generalizability of the findings. These considerations relate to the military setting adopted for the present scenario. Theoretically, the setting should exert little effect on the decision process. It is hypothesized that the decision process pattern exhibited by the subject will be predictive of his decision quality, regardless of specifics of the problem presented to him. This hypothesis is testable, and present intentions are to apply the decision processing scoring methods developed during a defensive planning operation to a problem involving offensive planning. This procedure will constitute a limited test of the hypothesis.

The military setting selected for the present test scenario involved large land forces functioning in a conventional non-nuclear environment. This setting, by itself, implies a host of considerations to a subject experienced in such a military environment. Therefore, the uncertainties of the military situation are reduced substantially. Doctrine is well established for the tactical employment of armored and mechanized forces; and the hard practicalities of moving such forces across rivers and of resupplying them during an offensive markedly restrict the tactical options available to a military planner. By contrast, if the selected military setting had been that of defensive planning in an unconventional limited war, it may be questioned whether the same decision process patterns would appear.

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[9] McNemar, Q. Psychological Statistics. New York: Wiley and Sons, Inc., 1949, p. 161.

The point at issue here is that there are two sets of uncertainties concerning the generalizability of the findings, one related to the decision problem presented to the test subject and one relating to the number of tactical options available in the simulated military test environment. The first set of uncertainties is systematically reduced by the test instructions provided the subject and by specific answers provided in response to his questions as he progresses toward solution. The second set of uncertainties is systematically reduced, for the knowledgeable subject, by responses to a few key questions whose significance in reducing uncertainty far exceeds their numerical importance. For example, as previously noted, the assumption must be made (for scoring purposes) of the equivalence of facts. Thus, the fact that the military setting is non-nuclear is, for scoring purposes, considered to be equivalent to the fact that the division has a certain number of armored personnel carriers. Each fact is scored as one point and is therefore numerically equivalent to each other fact. However, the fact that the setting is non-nuclear also implies tactical options to a knowledgeable subject (that massing of forces will be tactically permissible, for example) and uncertainties regarding his vulnerability or his effective operational control of these forces are therefore immediately reduced. Thus, this single fact provides a substantial amount of information in the sense of reducing uncertainty with respect to tactics.

Similarly, other facts (river fordability, road and terrain trafficability) coupled with knowledge of the type of enemy forces confronting him provide the experienced military planner with a severely restricted list of options available to the enemy. This deduction is possible because the commander is involved in conventional land warfare--unlike guerrilla activity, for example.

For the present research, selection of a conventional non-nuclear military setting was correct. It would be unwise to attempt to develop a stable criterion measure of decision-making behavior in the absence of some standard of decision quality (i.e., doctrine). Validation of the scoring techniques should also use a scenario portraying a conventional war environment. Results, however, should then be tested using scenarios portraying appreciably diverse military settings before they can be applied with confidence in measuring generalized decision-making behavior.

CONCLUSIONS

The experiment demonstrated the feasibility of preparing in advance a set of objective scoring standards which can be applied to the complex problem of evaluating military tactical decision making. For military planners interested in developing war games and businessmen concerned with evaluating management decision making, the present approach may have direct application. Decision-making tasks are commonly thought to be so complex that objective measurement of decision quality is not possible. The customary approach is therefore to permit free play and then to have an evaluator discuss the relative merits of the subjects' responses. Use of a single evaluator avoids interjudge disagreements.

Granting that the ultimate success or failure of a given military decision may be contingent upon fortuitous combinations of transient conditions, the fact remains that for specific complex decision situations it has been possible to derive objective scores of decision quality. (One is reminded of Napoleon's dislike for "unlucky" generals.) Apparently, there are sets of standards which can be applied to assess alternative choices available to the military tactician. In the present experiment, these standards were abstracted from CGSC lesson plans. Such carefully developed materials were essential for successful a priori scoring.

Related to the problem of deriving objective scoring standards is the finding that scoring decision quality tests in terms of their agreement with subject consensus standards does not constitute a profitable approach. This approach may have some merit if the test subjects are equally experienced and equally capable. But for the range of abilities represented in the present sample, it is clear that consensus scoring is unsatisfactory. The consensus standard involved the blending of high and low decision scores to derive the mean. Assigning high scores to responses which approximated this mean resulted in test scores which were statistically unrelated to any logically related variables.

With respect to the a priori scoring technique based upon the Leavenworth Standard, the resulting multiple correlation coefficient of .91 is considered sufficiently high for individual prediction purposes. A lower relationship would be anticipated if the experiment were to be replicated.

Results confirmed the hypotheses that tactical military decision quality is a function of the officer's experience, his ability, his decision process pattern, and the facts he possesses. Of these four predictors the most valuable score was decision process pattern which alone accounted for nearly half the common variance.

If indeed the manner in which a subject approaches a problem situation (his decision process pattern) is related to decision quality, then such a relationship should hold for a variety of problem situations. And if such generalization is supported, then it should be possible to improve decision quality in general by educating individuals in systematic problem solving techniques.

As a test of such generalizability, the test scenario used in the present experiment should be extended to include a combat portion and an offensive planning portion. The present defensive planning portion can be used to anchor the findings which will be derived from the extended scenarios. That is, the predictors used in the present experiment could serve to predict decision quality scores on the defensive planning scenario, thereby permitting the assessment of predictor validity for a new subject sample. The predictors would then be applied during the defensive combat portion to identify effective and ineffective decision makers. Presumably, the decisions recommended by the two extreme groups would be noticeably different. This would constitute one test of the validity of the concept.

Such a test could be further extended by similar predictions made for a new group of subjects engaged in a completely different (offensive planning) scenario. The evaluation method would be the same.

Finally, during such research, attention should again be given to the possibility of a quadratic relationship existing between number of facts possessed and decision quality. It is possible that there is indeed an optimum number of facts necessary for effective problem solution, and that a data base less than or in excess of this number exerts negative influence. A finding to this effect would raise a number of research considerations relative to information storage and retrieval as well as information display.

APPENDIXES

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SUBJECT BRIEFING

Experimenter reads the following to subject:

The Bunker-Ramo Corporation under contract to BESRL is studying tactical decision-making behavior. The ultimate goal of the research is to relate information display design to decision-making behavior.

We would like you to help in this effort by taking part in some very basic planning activities today. Since we cannot provide you with a full complement of staff element personnel, an automated data system has been provided as a decision aid.

Assume that you are the new G3 of the 20th Mechanized Division within 1st U. S. Army Corps now on alert status in assembly areas in Germany. The political situation is deteriorating rapidly.

Assume that no contingency plans are available. You will be given first instructions by excerpts from Corps OPORD.

In accomplishing your G3 activities, you may need information stored in the computer. When you request information, it will be displayed on your cathode ray tube (CRT) or displayed on your rear-projection screen. If you wish, you may request a print-out of information displayed on the CRT or on the screen.

Your first task will be to specify <u>avenues of approach</u>, <u>key terrain</u>, and recommend a <u>form of defense</u> for your division. Once this is done, you will be given further instructions concerning your next task.

You are linked to your computer operator by means of a telephone. He will encode your requests for data into machine language. Stored within the computer is detailed information relevant to most aspects of your problem. Major category headings are listed below:

<u>G1 Personnel</u>

Unit Strength Status
Personnel Management
Manpower Management
Morale

<u>G2 Intelligence</u>

Intelligence
- Enemy units
- Enemy personnel strengths
- Enemy weapons and equipment
- Attack doctrine

Information from Counterintelligence units

G3 Operations

Command organization
Training
Operation's status
Planning

G4 Logistics

Current supply status
Current maintenance
Transportation capability
Medical supply services
Other services

G5 Civil Affairs

Governmental functions
Economic status
Public facilities
Special functions

When you ask for information under any of these categories, be as specific as you can so that your computer operator can provide just the data you want. If what he provides is still too general, ask for the information again, but in more detail. There may, of course, be times when the information you request is not available.

Sometimes the information you request will be on several pages. In the upper right corner on your CRT display will be an entry showing whether more than one page is involved. If you are looking at a page that is, say, the first page of a two-page message, tell the operator when you have finished with the first page and he will display the second page.

There are several acetate screens on the wall. These are for your use as memo pads. Using a grease pencil, you may record items of data; or, if you wish, you may ask for a printout of a full display. If you request a printout, when you finish using it, please deposit it in the box we have provided. If you need that information again later, request the operator to give you another printout. Do not retrieve the data from the box.

You will have about two hours to select avenues of approach and key terrain, and recommend a form of defense. Using grease pencil, draw on your 1:50,000 map all the avenues of approach you have identified, and indicate the key terrain features. Then call the computer operator and tell him the form of defense you recommend. We will then ask you to describe why you have selected your particular answers.

Then, the division commander's guidance will be provided. (This may or may not coincide with your answers; we need a standard starting point for the next phase of the problem.) In this second phase you will be asked to develop your recommended course of action--that is, indicate your general outpost line on your 1:50,000 map, allocate your combat power to the echelons of defense (GOP, FDA, Reserve), and specify the nature of resistance for each. Three hours will be provided for this task. Again, we will ask you to describe why you have selected your particular answers.

Once again, commander's guidance will be provided on your CRT. (Once again, this may or may not coincide with your answers.) You will then have two hours to complete the final phase. Indicate on your 1:50,000 map overlay the following data:

Combat outpost coordination point

Brigade boundaries (lateral and rear)

Visualized FDA battalion positions

Visualized reserve forces location (general area and center of mass)

Visualized allowable penetrations into FDA

Visualized blocking positions

You will also be requested to recommend a task organization and to write mission statements for your brigade commanders. Forms will be provided to assist you. In addition, we will provide a brief questionnaire we would like you to complete.

For purposes of the study, today's date is 8 October, and it is now 0600 hours.

Do you have any questions before we begin?

APPENDIX B

CORPS OPERATIONS ORDER

1st (US) Corps
Kronach (PA6668) Germany
080600 October 1968

20th MECH DIVISION
OPORD 63

References: Map Western Europe (HOF PLAUEN 1:50,000, GERMANY 1:250,000)

Task Organization

20th Mech Div

- 2d Bn (155, SP), 631st Arty
- 262d ASA Co
- 2239th MID
- 210th CA Co.

52d Mech Div

- 2d Bn (155, SP), 632d Arty
- 263d ASA Co
- 2240th MID

23rd Armed Cav Regt

- 63rd Arty Gp
- 1st Bn (Hawk, SP), 458th Arty
- 501st Engr Bn
- 264th ASA Co
- 2241st MID

201st Armd Div

- 1st Bn, (Mech) 741st Inf
- 2d Bn, (155, SP) 634th Arty
- 665th ASA Co

312th Mech Bde

- 1st Bn, (Mech), 743d Inf
- 1st Bn, (Mech), 745th Inf
- 1st Bn, 221st Armor

1st Corps Arty

61st Arty Gp:

- 2d Bn (HJ), 105th Arty
- 2d Bn (8, SP), 615th Arty
- 2d Bn (8, SP), 617th Arty
- 2d Bn (155, SP), 635th Arty

62d Arty Gp:

- 2d Bn (HJ), 106th Arty
- 2d Bn (8, SP), 616th Arty
- 2d Bn (155, SP), 636th Arty
- 2d Bn (155, SP), 637th Arty
- 2d Bn (175, SP), 661st Arty

63d Arty Gp:

- 2d Bn (8, SP), 619th Arty
- 2d Bn (8, SP), 620th Arty
- 2d Bn (155, SP), 638th Arty
- 2d Bn (155, SP), 640th Arty

1. SITUATION

a. Enemy Forces

Immediately prior to ORANGE forces' occupation of Czechoslovakia in 1968 ORANGE forces conducted extensive maneuvers along East German borders. Following partial withdrawal of ORANGE forces from Czechoslovakia, these forces returned to the maneuver areas. ORANGE forces are also reported to be deployed along Czechoslovakian-West German border.

In recent weeks, there have been increasing reports of minor sabotage in West German border towns, and several teams have been apprehended. Diplomatic protests have been rejected. ORANGE forces have filed counter-charges of border violations in the HOF area.

Friendly intelligence sources report that ORANGE forces are preparing for an offensive to the southwest. Indications are that the 48th Combined Arms Army, reported in the vicinity of CHEMNITZ (US5434) will attack to gain control of the HOF gap.

b. Friendly Forces

(1) NATO forces, on alert status for the past week, have been ordered to assume defensive positions in the field.

(2) 30th (US) Army is to defend along the SAALE River in sector immediately, employing 2d (US) Corps and 1st (US) Corps from north to south.

(3) Elements of the 9th TAF to support 1st (US) Corps.

2. MISSION

Corps to move to defensive positions immediately and, in event of attack, to defend sector from REMPTENDORF (PB8801) to WEIBENSTADT (QA0654) for period of 30 days to permit buildup of NATO forces for a counteroffensive.

3. EXECUTION

a. Concept of Operation

(1) Maneuver. Corps to conduct a defense of assigned sector in three phases:

Phase I. Corps establishes defense in sector with the 201 Armd Cav Reg on the north, 20 Mech Div in the center, and the 52d Mech Div on the south; 23rd Armd Div and 312th Mech Bde are corps reserve to be located in the vicinity of NORDHALBEN (PA7883).

Phase II. Corps conducts defense of sector with 201 Armd Cav Reg in the north 20th Mech Div in the center, and 52d Mech Div in the south; allows no penetration west of line RED: 312th Mech Bde and 23rd Armed Div prepares for corps counterattack operations with priority for the 312th Mech Bde in the sector of the 201 Cav Reg; priority for the 23rd Armd Div in the sector of the 52d Mech Div.

Phase III. Corps counterattacks to destroy enemy forces penetrating the FDA.

(2) Fires

(a) Air. Priority of close air support to 52d Mech Div, 20th Mech Div, and 201st Cav Reg, in that order; then to Corps counter-attacking forces.

(b) Artillery. Priority to 52d Mech Div, 20th Mech Div, and 201st Cav Reg in that order; to corps counterattacking forces when committed.

(c) Nuclear. The bulk of the corps nuclear weapons will be allocated to the divisions in the FDA: allocation with authority to disperse and expend will be authorized if the aggressor employs nuclear weapons. Corps controlled weapons will be employed against enemy nuclear delivery systems, enemy reserves, and in support of corps counter-delivery systems, enemy reserves and in support of corps counter attacks.

b. <u>20th Mech Div</u>:

(1) Defend in sector immediately.

(2) Prevent enemy from penetrating west of line RED.

(3) Establish GOP by 081800 October.

c. <u>52d Mech Div</u>:

(1) Occupy and establish initial delay position along SAALE River in sector; establish GOP by 081800 October.

(2) Delay in sector; retain Hills 624 (QA 0704) and 593 (QA0678), allow no penetration west of line RED.

d. <u>201 Armd Cav Reg</u>:

(1) Defend in sector immediately.

(2) Establish GOP by 081800 October.

(3) Prevent enemy from penetrating west of line RED.

e. 23rd Armd Div: Corps Reserve

f. Arty:

(1) FA:

(a) 61st Arty Gp: GSR 20th Mech Div Arty.

(b) 62d Arty Gp: GSR 52d Mech Div Arty.

(c) 63d Arty Gp: GSR 23rd Armd Div Arty.

(d) 2d Bn (155, SP), 631st Arty: attached 20th Mech Div.

(e) 2d Bn (155, SP), 632d Arty: attached 52d Mech Div.

(f) 2d Bn (155, SP), 634th Arty: attached 201st Armd Cav Reg.

(g) 1st Bn (Tgt Acq), 101st Arty: GS.

(h) 1st Bn (SGT), 211th Arty: GS.

(i) Btry A (SGT), 191st Arty: GS.

(2) ADA

401st Arty Gp (AD): Priority to corps reserve, FDA, corps command post.

g. Aviation:

(1) 129th Avn Bn: GS

(2) 131st Avn Bn: GS

h. 301st Cml Bn (Smoke Genr): GS; priority to 20th Mech Div sector.

i. 51st Engr. Bde: GS.

(1) 54th Engr Gp (Cbt): GS; place one BN in direct support of 20th Mech. Div.

(2) 55th Engr Gp (Cbt): GS; place one BN in direct support of 52d Mech Div.

(3) 56th Engr Gp (Cbt): GS; place one BN in direct support of 201st Armd Cav Reg.

j. Barriers.

(1) Engineer units of 30th (US) Army assist in preparation of obstacles. 1st (US) Corps executes barrier system in sector to impede enemy passage of the SAALE River to the west, to delay and channelize enemy movement, to inflict casualties on the enemy, and to slow or halt enemy penetrations east of line RED.

(2) Concept of Operations.

(a) 1st Corps employs barriers making maximum use of natural obstacles and locally available resources.

(b) As a minimum, road and railroad bridges will be prepared for destruction; roads, defiles, and fords will be blocked in depth.

(c) Damage to communication centers, industrial facilities, and private and public property will be the minimum consistent with assigned missions.

(d) Unless otherwise specified, barriers will be constructed in the following priorities:

1. Forward (FEBA) barriers.

2. Barriers to contain enemy penetrations east of line RED.

3. Flank and intermediate barriers.

4. Rear barriers.

k. Engineer.

1st (US) Corps engineer units support the defense by preparing obstacles, constructing corps directed blocking positions, and maintaining roads and bridges.

(1) Concept of Operation.

51st Engr Bde supports 1st (US) Corps defensive operations employing 56th Engr Gp (Cbt) in the north, 54th Engr Gp (Cbt) in the center, and the 55th Engr Gp (Cbt) in the south in corps sector. Priority of effort in order, construction of corps blocking positions, preparation of obstacles, and road maintenance. Obstacles will be planned in depth on all avenues leading into corps sector.

1. Reserve:

(1) 312th Mech Bde:

(a) Priority of employment to sector of 201st Armd Cav Reg.

(b) Be prepared to protect corps north (left) flank.

(2) 23rd Armd Div: Priority of employment to sector of 52d Mech Div.

4. ADMINISTRATION AND LOGISTICS

a. ASR for period 8-15 Oct.

81 -mm motar, HE - 60
4.2 -in mortar, HE- 115
155 SP howitzer, HE - 70
8-in howitzer, HE - 40
Other types no restrictions

b. Special Ammunition Load

20th Mech Div:

155/Short Range Cannon/0.5 KT	2
155/Short Range Cannon/ 1 KT	1
8-in How/Medium Range Cannon/ 1 KT	1
8-in How/Medium Range Cannon/ 2 KT	2
HJ/ Free Flight Rocket/ 5KT	2
HJ/ Free Flight Rocket/ 10 KT (one corps weapon)	3
HJ/Free Flight Rocket/20KT (one corps weapon)	4
ADM/Air Delivered Weapon/ 1 KT	2

(1) SASP 972: vicinity KULMBACH (PA 7553)

(2) Special ammunition load can be drawn commencing 081400 October and will be completed no later than 091800 October.

5. COMMAND AND SIGNAL

1st (US) Corps signal units support the corps defense by installing, operating, and maintaining the corps signal system. Signal units also provide termination at all major elements of the command. Initial system to be in operation by 081200 October.

a. <u>Concept of Operation</u>.

The corps communication system will operate as prescribed in the 1st (US) Corps SOP. Emphasis will be placed on the use of existing commercial wire facilities under corps control when such facilities can be used without major rehabilitation. Increased use will be made of air messenger service.

b. <u>701st Sig Bn (Corps)</u>.

(1) Coordinate operations and continue training and combat service support of assigned and attached signal units.

(2) Install, operate, and maintain signal communication system and facilities for corps main, tactical, and rear echelons. Provide internal signal communications support for such other units and installations as directed. Provide corps photographic and messenger service.

(3) Provide signal combat service support including cryptographic to corps troops.

Distribution: A

2d (US) Corps

OFFICIAL:

/s/Malone
MALONE
G3

APPENDIX C

SCORING PROCEDURE: LEAVENWORTH STANDARDS

Decision-making behavior was measured during three consecutive test periods. In Subtest I, the subject recommended a form of defense based on his assessment of key terrain and possible enemy routes (avenues of approach) into his division sector. During Subtest II, the subject recommended a course of action for accomplishing the division mission. This recommendation included allocating combat power and specifying the nature of resistance to be offered along each avenue of approach. Subtest III involved development of a task organization to meet the enemy threat. Subject responses were recorded on acetate overlays, questionnaires, and dictaphone tapes. These responses were scored in terms of their agreement with optimum solutions identified in CGSC lessons. Based upon CGSC lesson plans, arbitrary weights were assigned, depending upon the degree to which subject responses departed from the school solutions. The procedures used in devising the weights assigned to each subject response in a subtest are described in this section. Scoring values are summarized in Tables appearing at the end of this section.

SUBTEST I. FORM OF DEFENSE

The major task to be accomplished by the subject during Subtest I was to recommend a form of defense within the assigned division sector. CGSC lesson plans identified the most likely avenues of approach, key terrain features, and the recommended form of defense.

Avenues of Approach. A vellum overlay provided by CGSC was used to score Subtest I. This overlay was placed on drawings made by the subject to determine agreement between the subject responses and school solutions. A value of one point was assigned to each avenue of approach drawn by the subject within the outlines of the avenues of approach depicted in the school solution. A maximum of five points was possible for this test item.

Key Terrain. The CGSC overlay was also used to score key terrain features. Key terrain features identified by the subjects which overlapped the boundaries of those identified by CGSC were each given a score of one point. A maximum of four points was possible for this test item.

Form of Defense. The subject verbally recorded his rationale for the form of defense (area defense or mobile defense) recommended. Transcripts of the interviews were reviewed to determine the form of defense the subject selected, and whether he recognized "avenue of approach A" as a main threat. The subject received one point for selecting the "proper" form of defense and an additional point for indicating "avenue A" as the main threat.

SUBTEST II. COURSE OF ACTION

During Subtest II, the subject was requested to indicate the nature of resistance to be offered (defend, delay, screen) along the general outpost line (GOPL) and in the forward defense area (FDA) of the divsion sector. He was also required to indicate the combat power (in terms of number and type of battalions) to be allocated to the maneuver elements in each of these areas and to the reserve forces. The subject drew his GOPL on an overlay of the situation map.

Placement of the GOPL was scored by positioning the CGSC overlay on top of the subject's drawing. Differential weights were assigned on the basis of a CGSC rationale which discussed the relative merits of each of several possible locations. Each remaining subject response was assigned a value of one point if it agreed with the CGSC solution. The following scores were applied:

GOPL Location - (Map overlay)	Score
1. Weisse-Elster River	2
2. 15 km forward of FEBA	1
3. 10-12 km forward of FEBA	0
4. All other locations	0
5. Not drawn	0
Degree of Resistance - (Data Collections forms)	
1. 1st Bde defends in north and 2nd Bde defends in south	1
2. 1st Bde delays in north and 2nd Bde delays in south	0
3. 1st Bde screens in north and 2nd Bde screens in south	0
4. GOP forces delay	1
5. GOP forces screen	0
6. GOP forces defend	0
Combat Power - (Data Collection forms)	
1. GOP	
a. 2 battalions	1
b. Other configurations	0
2. FDA	
a. 4 battalions in the north	1
b. 4 battalions in the south	1
c. Other configurations	0
3. Reserve	
a. 3 battalions	1
b. Provides 2 battalion GOP task force	1
c. Other configurations	0

Maximum score possible for Subtest II was nine points.

SUBTEST III. TASK ORGANIZATION AND GRAPHIC PORTION OF THE DEFENSE PLAN

A sizable portion of this subtest was devoted to the development of the graphic portion of a defense plan. The subject drew the graphic details of the defense plan on a situation map overlay. The following information was drawn on the overlay: GOPL (Even though the GOPL was included in Subtest II for scoring purposes, it was often not drawn until a subject reached Subtest III); Combat Outpost (COP) coordination point, brigade boundaries, FDA battalion positions, reserve force location, visualized allowable enemy penetrations, blocking positions, and artillery positions.

A CGSC overlay was used to score the subject's graphic responses. The values assigned to each item were as follows:

	Score
1. COP Coordinating Point (1:50,000 map)	
a. 1500 meters forward of the FEBA located on hills 527, 553, 543 or 547. (A deviation of $\pm$ 500 meters from these positions was accepted).	1
b. All other locations	0
2. Brigade boundaries (1:50,000 map)	
a. Lateral boundary	
(1) As drawn on CGSC overlay (A deviation of $\pm$ 1 km from school solution was accepted).	1
(2) Other locations	0
b. Rear boundary	
(1) As drawn on CGSC overlay (a discrepancy of $\pm$ 1 km from school solution was accepted).	1
(2) Other locations	0
3. FDA Battalion Positions (1:50,000 map)	
a. Battalions in the north	
(1) 3 battalions on the FEBA and 1 battalion in reserve	1
(2) Other configurations	0
b. Battalions in the south	
(1) 3 battalions on the FEBA and 1 battalion in reserve	1
(2) Other configurations	0
4. Reserve force location (1:50,000 map)	
a. Reserve location congruent with CGSC overlay trace	1
b. Other locations	0
5. Visualized allowable enemy penetrations	
a. As indicated on CGSC overlay, or 1 km beyond CGSC trace in the northern division sector.	1
b. As indicated on CGSC overlay or 1 km beyond CGSC trace in the southern division sector.	1
c. Other penetration depiction	0

6. Blocking Positions (1:50,000 map)
Only the blocking positions matching those on the CGSC overlay were counted as correct. Seventeen blocking positions were included in the school solution. Thus, the score for this item could range from zero to seventeen.

a. Blocking positions as indicated on CGSC overlay	1-17
b. Other positions	0

7. Artillery Positions

Artillery group depicted forward of the FEBA (map locations)	1
Not depicted forward of FEBA	0

DETAILED TASK ORGANIZATION. (DATA COLLECTION FORMS). The subject was requested to develop a detailed task organization of the division. Four different task organizations identified by CGSC were used to apportion weights in scoring this item. Additional scores were given to task organizations ranked in terms of the CGSC indications of relative merit:

Task Organization I (Data Collection Forms).

GOP	
. North: tank-heavy battalion and South: infantry-heavy battalion	1
. Other configuration	0
1st Brigade	
. Three infantry battalions, and 1 tank-heavy battalion	1
. Other configuration	0
. Minimum of two tank companies provided	1
. Less than two tank companies provided	0
2d Brigade	
. Three infantry battalions and 1 tank-heavy battalion	1
. Other configuration	0
. Minimum of one tank company provided	1
. Less than one tank company provided	0
3d Brigade	
. Three battalion reserve	1
. Other configuration	0
. Tank-heavy reserve	1
. No tanks	0
Selection of this task organization	3

Task Organization II

GOP	
. North: Tank-heavy battalion and South: Armored cavalry squadron	1
. Other configuration	0

1st Brigade	
. 3 infantry battalions and 1 tank-heavy battalion	1
. Other configurations	0
. Minimum of 2 tank companies provided	1
. Less than 2 tank companies provided	0
2d Brigade	
. 3 (-) infantry battalions and 1 infantry-heavy battalion	1
. Other configurations	0
. Minimum of 1 tank company provided	1
. Less than 1 tank company	0
3d Brigade	
. 3 battalions	1
. Other configuration	0
. Tank-heavy	1
. Not tank heavy	0
Selection of this task organization	3

Task Organization III

GOP	
. North: infantry-heavy battalion and South: Armored cavalry squadron	1
. Other configuration	0
1st Brigade	
. 3 (-) infantry battalions	1
. Other configurations	0
. 1 tank-heavy battalion	1
. Other configuration	0
2d Brigade	
. 3 (-) infantry battalions and 1 infantry battalion	1
. Other configurations	0
. Minimum of 1 tank company provided	1
. Less than 1 tank company provided	0
3d Brigade	
. 3 battalions	1
. Other configurations	0
. Tank-heavy reserve	1
. No tanks	0
Selection of this task organization	2

Task Organization IV

GOP	
. North: Armored cavalry squadron and South: infantry-heavy battalion	1
. Other configurations	0
1st Brigade	
. 3 (-) infantry battalions and 1 tank-heavy battalion	1
. Other configurations	0
. Minimum of 2 tank companies provided	1
. Less than 2 tank companies	0

2d Brigade	
. 3 (-) infantry battalions and 1 infantry-heavy battalion	1
. Other configurations	0
. Minimum of 1 tank company provided	1
. Less than 1 tank company	0
3d Brigade	
3 battalions	1
Other configurations	0
Tank-heavy reserve	1
No tanks	0
Selection of this task organization	1

ARTILLERY TASK ORGANIZATION. The artillery task organization solution developed by CGSC was directly applicable to each of the previously defined maneuver element organizations. The artillery task organization was scored as follows:

GOP	
. 1-47 artillery and 2-631st artillery initially assigned to the GOP	1
. 1-47 not initially assigned to GOP	0
. 1-48 artillery initially assigned to the GOP	1
. 1-48 not initially assigned to GOP	0
. A/1-439 air defense artillery (ADA) initially assigned to GOP	1
. A/1-439 not initially assigned to GOP	0
1st Brigade	
. 1-45th Artillery	1
. 1-45th Artillery not assigned	0
. B/1-439 ADA	1
. B/1-439 ADA not assigned	0
2d Brigade	
. 1-46 Artillery	1
. 1-46 Artillery not assigned	0
. A/1-439 after withdrawal of GOP forces	1
. A/1-439 not assigned after withdrawal of GOP	0
3d Brigade	
. 1-47th Artillery and 2-631 artillery after withdrawal of GOP	1
. 1-47 and 2-631 not assigned after withdrawal of GOP	0
Division Artillery	
. 1-49th Honest John assigned	1
. 1-49th Honest John not assigned DIVARTY	0
. 1-48th after withdrawal of GOP	1
. 1-48th not assigned DIVARTY	0

Combat Engineer: Task Organization

• GOP - Engineer support indicated	1
• GOP - Engineer support not indicated	0
• 1st Brigade - engineer support indicated	1
• 1st Brigade - engineer support not indicated	0
• 2d Brigade - engineer support indicated	1
• 2d Brigade - engineer support not indicated	0
• 3d Brigade - engineer support indicated	1
• 3d Brigade - engineer support not indicated	0

Subtest III maximum score possible was 50 points.

Although the above scoring standards were selected to maximize scoring objectivity, judgment situations were not entirely eliminated. For example, if ADA companies were assigned to the appropriate units but company designators were not utilized, full credit was still given for the response. Partial credit was sometimes given for task organizations that appeared to be fairly equivalent to those recommended by CGSC.

It was occasionally necessary to review all of a subject's responses before scoring a test item. When a unit designation was unclear on a task organization form, it could often be identified by examining the subject's mission statements to subordinate units.

Regrouping of Scores

The preceding account described scoring procedures in terms of the three subtests. The subtests represented logical pauses in the recommended decision sequence for developing an operations plan. They also provided a means for controlling subject response variability. Commander's Guidance was offered during these pauses so that the subjects would begin each subtest from a common departure point.

Inspection of the test items which were scored suggested that the several subtests might not be highly homogeneous in terms of skills they were intended to assess. Also, because of this heterogeneity, it appeared possible that anticipated relationships among information accessed and test scores might be masked. Specifically, many of the items appeared to require no more information than the subject already had available in terms of the terrain map, the corps operations order, and his specific mission assignment. It was considered desirable to extract these items from the total set, and to refer to the hypothesized skills which they ostensibly assess as map reading skills.

A "Map Reading Score" was developed by summing scores (computed as described above) for the following test items:

Avenues of approach score
Key terrain score
COP coordinating point score
Brigade boundaries score
Blocking positions score

The remainder of the items appeared to be assessing some form of military tactics skill. They can be logically divided into two scores, one concerned with locating forces geographically to counter an anticipated threat, and one concerned with the composition of such forces. The "Forces Location" score consisted of a summation of scores for the following items:

GOP location, power, mission
FDA forces allocations, missions
Reserve force allocation and location scores
Visualized penetrations score

The "Forces Composition" score consisted of a summation of scores for the following items:

Composition of GOP forces score
Composition of brigades score
Artillery scores
Engineer scores
Rear security score

The "Form of Defense" would normally be regarded as part of the tactics score, but it was dropped from the present analysis because of lack of discriminating power among the test subjects.

SUBTEST I FORM OF DEFENSE

Avenues of Approach (1:50,000 map)

	Score: Correctly Drawn	Score: Incorrectly Drawn
1. Avenue A	1	0
2. Avenue B	1	0
3. Avenue C	1	0
4. Avenue D	1	0
5. Avenue E	1	0

Key Terrain Feature (1:50,000 map)

	Score: Correctly Drawn	Score: Incorrectly Drawn
1. Hill mass 715, 795, 726	1	0
2. Hill 651	1	0
3. Hill 614	1	0
4. Hill 660	1	0

Main Threat (Interview record)

1. Avenue A indicated as main threat approach. 1
2. Avenue A not indicated as main threat approach. 0

Form of Defense

1. Area 1
2. Mobile 0

SUBTEST SCORE POSSIBLE 11

SUBTEST II COURSE OF ACTION

Location of GOPL (1:50,000 map)	Score
1. Weisse Elster River	1
2. 15 Km forward of FEBA	1
3. 10-12 Km forward of FEBA	0
4. All other locations	0
5. Omitted	0

Degree of Resistance (Data Collection forms)	Score
1. 1st Bde defends in north 2nd Bde defends in south	1
2. 1st Bde delays in north 2nd Bde delays in south	0
3. 1st Bde screens in north 1st Bde screens in south	0
4. GOP forces delay	1
5. GOP forces screen	0
6. GOP forces defend	0

Combat Power (Data Collection form)	Score
1. GOP	
. 2 battalions	1
. other Configurations	0
2. FDA	
. 4 battalions in the north	1
. 4 battalions in the south	1
. other Configurations	0
3. Reserve	
. 3 battalions	1
. provides 2 battalions GOP task force	1
. other Configurations	0
SUBTEST SCORE POSSIBLE	9

SUBTEST III TASK ORGANIZATION - GRAPHIC PORTION OF DEFENSE PLAN

	Score
1. COPL (1:50,000 map)	
. 2500 meters forward FEBA or on Hills 527, 553, 543 or 547 (± 500 meters allowed).	1
. All other locations	0
2. Brigade Boundaries (1:50,000 map)	
a. Lateral Boundary	
. As drawn on CGSC overlay (± 1 km either side of school solution allowed)	1
b. Rear boundary	
. As drawn on CGSC overlay (± 1 km either side of school solution allowed)	1
. Other locations	0
3. FDA Battalion Positions (1:50,000 map)	
a. Northern battalions	
. 3 battalions at the front, 1 battalion reserve	1
. Other configurations	0
b. Southern battalions	
. 3 battalions at the front, 1 battalion reserve	1
. Other configurations	0

	Score
4. Location of Reserve (1:50,000 map)	
. Located in accord with school solution	1
. Other locations	0
5. Visualized Allowable Enemy Penetrations	
. Northern portion of division area -- in accord with school solution or 1 km beyond	1
. Southern portion of division area -- in accord with school solution or 1 km beyond	1
. Other visualized penetration	0
6. Blocking Positions	
. As indicated in school solution	1
. Other positions	0
7. Artillery Positions	
GOP (1:50,000 map)	
. Artillery Group depicted forward of FEBA	1

SUBTEST III (Continued)

8. Task Organization — Score

Task Organization I

Task Organization	Score
GOP	
. N - tk hvy bn, S - inf hvy bn	1
. Other configurations	0
1st Bde	
. 3 inf bns, 1 tk hvy bn	1
. Other configurations	0
. Min 2 tk Co.	1
. Other	0
2d Bde	
. 3 inf bns, 1 tk hvy bn	1
. Other configurations	0
. Min of 1 tk Co.	1
. Other	0
3d Bde	
. 3 bn res	1
. Other configurations	0
. Tk hvy res	1
. Other	0
Select this TO	3

Task Organization II

Task Organization	Score
GOP	
. N - tk hvy bn, S - inf hvy bn	1
. Other configurations	0
1st Bde	
. 3 inf bns, 1 tk hvy bn	1
. Other configurations	0
. Min 2 tk Co.	1
. Other	0
2d Bde	
. 3 (-) inf bns, 1 inf hvy bn	1
. Other configurations	0
. Min of 1 tk Co.	1
. Other	0
3d Bde	
. 3 bns	1
. Other configurations	0
. Tk hvy res	1
. Other	0
Select this TO	3

Task Organization III

Task Organization	Score
GOP	
. N - inf hvy bn, S - ACS	1
. Other configurations	0
1st Bde	
. 3 (-) inf bns	1
. Other configurations	0
. 1 tk hvy bn	1
. Other configurations	0
2d Bde	
. 3 (-) inf bns, 1 inf bn	1
. Other configurations	0
. Min of 1 tk Co.	1
. Other	0
3d Bde	
. 3 bns	1
. Other configurations	0
. Tk hvy res	1
. Other	0
Select this TO	2

Task Organization IV

Task Organization	Score
GOP	
. N - ACS, S - inf hvy bn	1
. Other configurations	0
1st Bde	
. 3 (-) inf bns, 1 tk hvy bn	1
. Other configurations	0
. Min 2 tk Co.	1
. Other	0
2 Bde	
. 3 (-) inf bns, 1 inf hvy bn	1
. Other configurations	0
. Min of 1 tk Co.	1
. Other	0
3d Bde	
. 3 bns	1
. Other configurations	0
. Tk hvy res	1
. Other	0
Select this TO	1

SUBTEST III (Continued)

9. Artillery Task Organization	Score
GOP (data collection forms)	
. 1-47, 2-631 initially to GOP	1
. 1-47, 2-631 not to GOP	0
. 1-48, initially to GOP	1
. 1-48, initially not to GOP	0
. A/1-439 ADA initially to GOP	1
. A/1-439 ADA not to GOP	0
First Brigade	
. 1-45th assigned	1
. 1/45th not assigned	0
. B/1-439 ADA assigned	1
. B/1-439 ADA not assigned	0
Second Brigade	
. 1-46th assigned	1
. 1-46th not assigned	0
. A/1-439 after GOP	1
. A/1-439 not assigned after GOP	0
Third Brigade	
. 1-47, 2-631 after GOP	1
. 1-47, 2-631 not assigned after GOP	0
10. Division Artillery	
. 1-49 assigned	1
. 1-49 not assigned	0
. 1-48 after GOP	1
. 1-48 not assigned after GOP	0

11. Engineering Task Organization	Score
GOP	
. Support indicated	1
. Support not indicated	0
First Brigade	
. Support indicated	1
. Support not indicated	0
Second Brigade	
. Support indicated	1
. Support not indicated	0
Third Brigade	
. Support indicated	1
. Support not indicated	0
12. Rear Area	
. Security considered	1
. Security not considered	0
SUBTEST SCORE POSSIBLE	50

Summary

Subtest I	-	11
Subtest II	-	9
Subtest III	-	50
TOTAL POSSIBLE TEST SCORE		70

APPENDIX D

SCORING OF EXPERIENCE QUESTIONNAIRE

GCSC Experience

Scores were apportioned on the following basis:

25 points if graduated	1967 - 68	
20 points " "	1965 - 66	
15 points " "	1963 - 64	
10 points " "	1961 - 62	
5 points " "	1959 - 60	
0 points " "	1958 - or earlier	
0 points if did not attend CGSC		

In addition, five points were subtracted from the above scores if the subject had not taken the regular course. The distribution of scores was normalized.

Training Exercises

This score was the absolute number of exercises which the subject reported he had participated in. Only training exercises in West Germany were considered. Exercises included Advanced Troop Training, Field Training Exercises, Command Post Exercises, and Map Exercises. Zero points were scored if subject lacked West Germany experience. Distribution of scores was normalized.

Mechanized Infantry Experience

This was a composite score reflecting level of job responsibility, level of command in which the subject worked, and length of time in the assignment. The score was computed by multiplying months in the assignment by the following:

3 Points	2 Points	1 Point
Div. G-3 or Asst G-3	Div Staff	Co. Cmdr
Bde Cmdr or XO	Bde Staff	Plat. Ldr
Bde S-3 or Asst S-3	Bn Staff	Sq. Ldr
Battle Group S-3	Army Staff	
Bn Cmdr or Asst Cmdr	MAAG Staff	
Bn XO, S-3 or Asst S-3		

Zero points were scored if the subject was not directly assigned to a Mechanized Infantry unit.

The subject's scores in each assignment were summed to derive the total score. The distribution was then normalized.

Combat Experience

The same scoring formula was used to compute the combat experience score in order to credit task duration, level of responsibility, and level of command. All combat months were scored, regardless of military branch, and were summed across assignments for each subject. The distribution was then normalized.

APPENDIX E

Z-SCORE CONVERSION TABLE

Z	EL	EI	EX	ALC	ALW	PSEQ	PDRR	PRS	PTP	FACT
76			32							
75										
74										
73										
72			28							.05415
71										
70						87.5				
69		88			Excellent		4			
68										
67	25	80					5			
66		78								
65				.048			6			
64		73						6		.04380
63				.108		75.0	7			.04338
62				.137						
61	20	61		.144		71.4	8			.03986
60						70.3			0	
59							9		5	
58			16	.212					10	
57		48	15				10			.03514
56	15		14		Above Ave				15	.03335
55		42	13	.305		61.5	11		20	.03275
54			12			60.0		5	25	.03023
53			11			58.0	12		30	.02962
52		33	10	.372		55.5			35	
51	10		9			54.5	13			.02750
50			8	Unkn	Unkn				40	
49			7				14		45	
48			7	.470					50	.02273
47			6				15			
46			5							.02072
45	5	12	4			42.8	16			
44		8	3	.568						
43			2		Average		17	4	70	
42		0	2	.616					75	.01572
41			1				18		80	.01352
40			0			34.4			85	
39	0						19		90	.01048
38						31.2				.00936
37							20			
36						27.5				
35							21			
34										.00455
33							22	3		
32										
31							23			
30				.894	Below Ave					
29				.930		15.3				
28										
27									140	
26										
25									150	

LEGEND: APPENDIX E

EL	=	experience at the USA Command and General Staff College (CGSC)
EI	=	experience in mechanized infantry units
EX	=	experience in West Germany field exercises
ALC	=	class standing at graduation from CGSC
ALW	=	CGSC rating on verbal and written expression
PSEQ	=	request dyad sequence
PDRR	=	data request runs
PRS	=	request slope
PTP	=	terminal pause

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13. ABSTRACT

The Command Systems program within the USA Behavior and Systems Research Laboratory (BESRL) is concerned with human factors problems of information presentation, processing, and utilization in command and control systems. One major objective is to provide research findings by which information assimilation and decision making may be facilitated. The present publication describes research to develop and evaluate a scenario for a test of tactical military decision making and to derive methods for scoring the decision-making behavior for use in a broad program of manned systems research to improve tactical decision making.

The experimentation was conducted by personnel of the BUNKER-RAMO Corporation in BESRL's Simulated Tactical Operations System (SIMTOS) facility. A test scenario was developed and administered individually to 20 senior field grade officers. The assigned task required each officer to write a defense plan for his division sector against an expected attack by two mechanized infantry divisions. The scenario was presented by using cathode ray tube (CRT) displays, computer-driven typewriters, and random access slide projection equipment. Defense plans were scored using USA CGSC school solutions as criteria. Two scoring procedures were utilized: 1) Leavenworth Standard (based on rationales and solutions in the CGSC lesson plans) and 2) Consensus Standard (to provide for computing average subject responses in the event CGSC Standards were inappropriate as a result of scenario changes.

The experiment demonstrated the practicality of developing a priori scoring standards for complex decision-making tasks. The test proved reliable. Measures of the

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Information assimilation						
*Command information processing systems						
*Scenario						
Command and control systems						
*Information presentation						
*SIMTOS (Simulated Tactical Operations System)						
Laboratory facilities						
*CRT (cathode ray tube)						
*Decision quality						
Computer communication						
Manned systems research						

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13. Abstract - continued

decision-making behavior of the officers were highly correlated with the criterion score. A combination of four measures, Experience, Ability, Decision Process Pattern, and Significant Facts, were highly effective as criterion score predictors.